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Werner Raub/Vincent Buskens

Theory and Empirical Research in Analytical Sociology: The Case of Cooperation in Problematic Social Situations*

Abstract: The integration of theory and empirical research in analytical social science has always been a core topic of *Analyse & Kritik*. This paper focuses on how analytical theory and empirical research have moved closer to each other in sociology, using rational choice theory and game-theoretic models as well as empirical research on problematic social situations (social dilemmas, collective action problems, etc.) as an example. We try to highlight the use of complementary research designs (surveys, vignette studies, lab experiments) for testing the same hypotheses. We also try to show that empirical research indicates the need for the development of more complex theoretical models.

0. Introduction

Analyse & Kritik has been launched 30 years ago, in 1979, as a platform for contributions on the interface of analytical philosophy and analytical social science (Baurmann/Leist/Mans 1979a; 1979b), including analytical sociology, broadly conceived (see, e.g., Hedström 2005).¹ What is more, from the beginning *Anal-*

* We benefited from discussions over the years with Jeroen Weesie and other members of our Utrecht group *Cooperation in Social and Economic Relations*. We acknowledge financial support for Raub by the Netherlands Organization for Scientific Research (NWO) under grants S 96-168 and PGS 50-370 for the PIONIER-program *The Management of Matches*, under grant 400-05-089 for the project *Commitments and Reciprocity* and for Buskens by Utrecht University for the High Potential-program *Dynamics of Cooperation, Networks, and Institutions*.

¹ Likewise, *Analyse & Kritik* was launched to help fostering a synthesis between analytical philosophy and what was labeled ‘critical social science’ (‘kritische Sozialwissenschaft’, Baurmann/Leist/Mans 1979a; 1979b). On this, Alasdair MacIntyre’s dictum at the very beginning of the first and programmatic article in *Analyse & Kritik* (Baurmann/Leist/Mans 1979a, 1) is illuminating: “[...] I cannot resist remarking that to synthesize analytical philosophy with Frankfurt School Marxism seems to me to be an attempt to tie two sinking ships together. At least the splash as they submerge should be bigger.” Although not being professional philosophers, we doubt that conceiving of analytical philosophy as a sinking ship was entirely appropriate. With hindsight, MacIntyre’s skepticism with respect to the prospects of synthesizing analytical philosophy with critical social science à la Frankfurt School Marxism seems more on the mark. More importantly, though, MacIntyre’s remark at the beginning of their program for the journal indicates the open-mindedness of the editors of the journal (and their

yse & Kritik focused on the interface of analytical social theory and empirical social research. In fact, the first of the two programmatic editorials by Baurmann, Leist, and Mans was on precisely this issue. It seems fair to state—and this was very much the point of departure of Baurmann, Leist, and Mans—that analytical approaches in social science were highly controversial at the end of the 1970's, with social theory and empirical research being far apart.²

Analytical approaches in sociology were certainly controversial and rational choice approaches as one variant of analytical sociology even more so. And it was a major weakness of analytical sociology in general and presumably even more so of rational choice sociology in particular that close ties with systematic and cumulative empirical research were largely absent. In fact, this situation prevailed for quite some time until, say, the middle of the 1990's. This can be seen not only from Green and Shapiro's (1994) influential criticism of rational choice approaches in social science that was mainly targeted at the weak links of these approaches with empirical research (see Friedman 1996 for discussions of the Green-Shapiro critique). Arguably, the same weakness is also reflected in the work of the major driving force of rational choice sociology: James Coleman. It is beyond doubt that Coleman has been a towering figure in sociology and social science through the depth and breadth of his contributions to theory, to empirical research in diverse fields, specifically in education research, contributions to methodology, including mathematical sociology, and through his focus on applications of social theory and research for 'social technology' (see, e.g., Clark 1996). However, it seems hard to deny that what characterizes the relations between his theoretical, empirical, and methodological contributions is largely "mutual agnosticism" (Mayer 1998, 187). As Mayer puts it:

"Es spricht einiges für die These, dass die empirischen und theoretischen Arbeiten James Colemans im wesentlichen voneinander getrennt und parallel verlaufen, ohne dass man wirklich davon sprechen könnte, dass die empirischen Untersuchungen theoretischen Fragestellungen entsprungen oder darauf gerichtet gewesen seien, theoretisch abgeleitete Fragen zu beantworten. Im übrigen scheint dies ebenso für den Methodologen Coleman zu gelten. Seine mathematische Soziologie beeinflusste weder seine empirischen Untersuchungen, noch [...] sein theoretisches Werk."

In a similar vein, Heckman and Neal (1996, 99) argue: "Like many distinguished scholars, [Coleman] pursued a number of different styles and lines of research,

sense of humor) as well as the journal's aim (we dare to say: an aim in the best Popperian sense) to serve the critical discussion of alternative and competing theories and research programs. No wonder then—and another sign of the journal's strength—that quite some space of *Analyse & Kritik* has been devoted over the years to MacIntyre's work and comments on his work.

² Thanks to neoclassical approaches as well as analytically inspired criticisms of neoclassical approaches such as the new institutional economics, transaction cost theory, and also the rapid emergence of game-theoretic modeling, the problem situation in economics was different already at that time.

often at the same time. Many pots were always on the stove, and they were not all cooking the same stew.”

There had been exceptions. For example, German sociologists like Ziegler, Hummell, Opp, and a bit later Esser pushed analytical approaches in sociology already in the early 1970’s, engaged themselves in empirical research, and *did* focus on the integration of analytical theory and empirical research, also in their own work, certainly so Opp, who was never reluctant to empirically test implications of rational choice models (see, e.g., Opp/Burow-Auffarth/Heinrichs 1981; Opp et al. 1984 for relatively early examples of explicit attempts to systematically test sociological hypotheses generated from rational choice assumptions empirically). In the Netherlands, Wippler and Lindenberg, later joined by Stokman, initiated the working group *Explanatory Sociology* in the 1970’s and subsequently, in the 1980’s, a sizable institution, the *Interuniversity Center for Social Science Theory and Methodology* (ICS), with the explicit aim of integrating analytical sociology and more specifically ‘structural-individualistic’ sociology with empirical research (see Wippler 1978).

In due course, these exceptions have been gaining ground. For example, Goldthorpe (2000 [2007]), in his collection of essays, including his widely recognized programmatic statement *The Quantitative Analysis of Large-Scale Data Sets and Rational Action Theory: For a Sociological Alliance* (1996), forcefully argued in the same direction, pointing out that the problem was not only a feeble empirical basis of much rational action theory in sociology and the need of rational action theory to use empirical regularities revealed by large-scale survey research as *explananda* but, conversely, also the need of much large-scale survey research to employ rational action theory as a tool to provide an *explanans* for those *explananda* (see Breen/Goldthorpe 1997 as a sketch of how to implement the alliance between rational action theory and large-scale survey research). Goldthorpe’s plea seems to have encouraged quite some work by theorists as well as empirical researchers aimed at reducing the gap between analytical theory and more specifically methodological individualism and rational choice approaches on the one hand and empirical research in sociology on the other (see Blossfeld/Prein 1998 for a nice example). In fact, Wittek, Snijders, and Nee (forthcoming) is a major handbook entirely aimed at taking stock of this development. We wonder whether, say, a systematic quantitative content analysis of sociology journals might confirm our impression that an alliance à la Goldthorpe is indeed emerging and we tend to believe that such an emerging alliance has contributed to considerably more acceptance of analytical theory and rational choice modeling in sociology in general and certainly in the scientific community of advanced quantitative empirical researchers in sociology.

Our contribution to *Analyse & Kritik*’s 30th anniversary pursues the integration of analytical social theory and empirical research. We try to do so by providing evidence, by way of example, in a highly stylized fashion, and using own previous work, for three related claims.

1. Analytical theory and particularly rational choice theory in sociology and empirical research have indeed moved closer to each other.

2. The integration of theory and empirical research is served by employing complementary research designs for testing the same hypotheses. In this way, we also hope to extend Goldthorpe's program by conceiving his 'quantitative analysis of data' more broadly, including not only survey designs but also, e.g., experiments and quasi-experimental designs such as vignette studies.
3. The interplay of formal theoretical model building and empirical research is more complex than is sometimes naively believed. Specifically, empirical research often indicates the need for the development of more complex—rather than more simple—theoretical models. This provides strong justification for increasing the complexity of formal theoretical models.

Our examples represent theoretical and empirical work on 'problematic social situations' (Voss 1985; Raub/Voss 1985). With 'problematic social situations' we refer to situations of strategic interdependence such that an outcome that is socially beneficial for the actors directly involved in the technical sense of Pareto optimality is not an outcome of (Nash) equilibrium behavior of the actors. Thus, at least one of the actors has an incentive to 'defect' by behaving 'opportunistically', i.e., in a selfish way that impairs the other actor(s). Conversely, there is an equilibrium that is Pareto inefficient and inferior to the socially beneficial outcome. Hence, using Rapoport's (1974) instructive terminology, in problematic social situations 'collective rationality' in the sense of reaching the socially beneficial outcome is at cross purposes with 'individual rationality', i.e., incentive-guided and goal-directed behavior as formalized by the Nash equilibrium concept. These are situations that are often referred to as 'social dilemmas' in social psychology and in sociology, while 'collective action problems' and 'public goods problems' are commonly used labels in political science and economics. Parsons' (1937) problem of order is pertinent in problematic social situations. Analytical approaches in this area and specifically game-theoretic and game-theoretically inspired work have often been prominently featured in *Analyse & Kritik*, starting with Kliemt and Schauenberg's (1982) illuminating discussion of Taylor's (1976 [1987]) ground-breaking *Anarchy and Cooperation* and numerous later articles by a wide variety of authors (see *Analyse & Kritik*'s highly useful electronic archive of all issues so far). We focus on a specific and important type of problematic social situations, namely, trust problems in economic exchange. We review theoretical and empirical work on how 'social embeddedness' of trust problems affects actors' behavior and the 'solution' of trust problems.

More specifically, the set-up of our paper is as follows. In the next section, we sketch how to model trust problems, conceptualize the 'embeddedness' of such problems, and summarize hypotheses on embeddedness effects that follow from a variety of formal theoretical models. In the subsequent section, we outline a number of empirical studies that employ alternative and complementary research designs for testing such hypotheses and review the evidence from those studies. We conclude with a summary of how our overview of theory, hypotheses, and empirical evidence supports our three claims and with some suggestions for a research agenda.

1. How Social Embeddedness Affects Trust: Theory and Hypotheses

We conceptualize a trust problem following Coleman (1990, 97–99) as a situation with strategic interdependence between two actors, the trustor and the trustee. Coleman emphasizes four features:

1. Placing trust by the trustor allows the trustee to honor or abuse trust, while this alternative is not available for the trustee without placement of trust.
2. Compared to the situation with no trust placed, the trustor is better off if trust is placed and honored but is worse off if trust is abused.
3. There is no ‘real commitment’ (Coleman 1990, 98) of the trustee to honor trust. Thus, the trustor voluntarily places resources in the hands of the trustee.
4. There is a time-lag between placement of trust by the trustor and the action of the trustee.

Trust problems in this sense are typically associated with economic as well as social exchange. E.g., a buyer who has ordered and (pre)paid goods to be delivered by a supplier may wonder whether the supplier will deliver in due time, will deliver adequate quality, and will provide adequate service. Investing time and effort in helping a friend, hoping for receiving help from the friend in return sometimes in the future, is an example of social exchange involving a trust problem.

1.1 The Trust Game

The standard Trust Game is a game-theoretic representation of a trust problem (Camerer/Weigelt 1988; Dasgupta 1988; Kreps 1990). The Trust Game starts with a move by the trustor, who chooses between trusting the trustee (i.e., she is ‘trustful’) and not trusting the trustee. If the trustor does not trust, the game is over, with trustor and trustee each obtaining a payoff P . If the trustor trusts, the trustee chooses between honoring trust (i.e., he is ‘trustworthy’) and abusing trust.³ If the trustee honors trust, trustor and trustee each receive $R > P$. If the trustee abuses trust, the trustor receives $S < P$, while the trustee receives $T > R$. For the time being, we assume that these payoffs represent utilities for the actors.⁴

³ Subsequently, the noun ‘trust’ is used as shorthand for ‘trustfulness *and* trustworthiness’. Only when used as a verb or in conjugations such as ‘abuse trust’ and ‘honor trust’, trust refers exclusively to ‘trustfulness’.

⁴ It is not necessary to assume that trustor and trustee receive the same payoff P when the trustor is not trustful or that they receive the same payoff R when trust is honored.

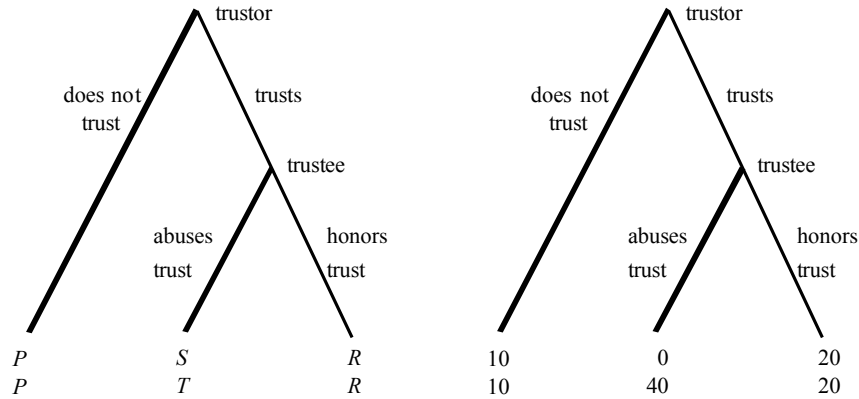


Figure 1: Extensive form of a Trust Game. $T > R > P > S$. The right-hand Trust Game is a numerical example used in the experiment described in section 2 below. Bold lines indicate the equilibrium path of play.

Assume now that the game with all payoffs is known to both actors, each actor maximizes own payoffs, and everybody acts rationally.⁵ Then, the trustee will abuse trust if the trustor trusts, because the payoff for abusing trust is larger than the payoff for honoring trust ($T > R$). The trustor realizes that the trustee would abuse trust. Thus, because the trustor is better off if she does not trust than when she does trust and trust is abused ($P > S$), she will not trust. Bold lines in Figure 1 indicate these moves of trustee and trustor. In the technical language of game theory, not trusting, while trust would be abused represents the (unique) subgame-perfect equilibrium of the Trust Game. The game constitutes a problematic social situation because both actors are worse off when the trustor does not trust than in the case where the trustor trusts and trust is honored ($R > P$). The Trust Game can be conceived as a one-sided version of the Prisoner's Dilemma, since in the Trust Game there is only one actor who can profit from acting opportunistically. Note, too, that we focus here on trust problems due to incentives of the trustee. Such trust problems can be distinguished from problems due to uncertainty of the trustor about the abilities and competencies of the trustee. These latter problems are sometimes labeled problems of 'confidence' (e.g., Barber 1983; see also Snijders 1996, chapter 1 for a discussion).

⁵ We thus focus on 'calculative trust' in Williamson's (1993) sense.

1.2 Embeddedness of Trust Problems

Embeddedness (Granovetter 1985) means that the actors involved in a trust problem maintain an ongoing relation with prior and expected future interactions. We refer to this as ‘dyadic embeddedness’. An example is a buyer who repeatedly purchases goods from the same supplier. Furthermore, a trust problem can be related to interactions of trustor or trustee with third parties. The buyer may happen to know other buyers who purchase goods from the same supplier. We refer to this as ‘network embeddedness’.⁶

Buskens and Raub (2002) distinguish two mechanisms through which dyadic and network embeddedness may affect trust. One of these mechanisms is control. This refers to the case that the trustee has short-term incentives for abusing trust, while some long-term consequences of his present behavior depend on future behavior of the trustor. More precisely, if the trustee honors trust now, the trustor may be able to reward this by applying positive sanctions in the future. Conversely, if the trustee abuses trust now, the trustor may be able to punish this by applying negative sanctions in the future. Given dyadic embeddedness, the trustee has to take into account that honoring trust may affect whether or not the trustor trusts again in the future. Given network embeddedness, the trustee has to take into account that a trustor can inform third parties on the trustee’s behavior, such as other trustors with whom the trustee may be involved in future trust problems. Again, whether or not other trustors are willing to trust the trustee in the future may depend on whether the trustee honors or abuses trust now. Thus, the trustee has to trade off the short-term incentives to abuse trust against the long-term benefits of honoring trust and the long-term costs of abusing trust. This mechanism is also known as conditional cooperation (Taylor 1976 [1987]) or reciprocity (Gouldner 1960; Blau 1964 [1996]; Diekmann 2004). Reciprocity in this sense can be driven exclusively by long-term, ‘enlightened’ self-interest of the actors.⁷

Embeddedness may affect trust through a second mechanism, namely, learning. Assume that the trustor is not completely informed on the behavioral alternatives and incentives of the trustee. For example, a buyer may not know for sure whether a supplier has an incentive or an opportunity for delivering with a delay or delivering bad quality. Beliefs of the trustor on the trustee’s characteristics can be affected by information on past interactions. This in-

⁶ In addition, there may be institutions that have repercussions for the actors’ opportunities, incentives, or information. Elsewhere (e.g., Buskens/Raub forthcoming), we refer to this as ‘institutional embeddedness’. Institutions can and often do enhance dyadic and network embeddedness. An example is a feedback forum on an internet platform such as eBay that provides network embeddedness for transactions between otherwise anonymous buyers and sellers.

⁷ Reciprocity in this sense (sometimes labeled ‘weak reciprocity’, e.g., Fehr/Schmidt 2006, 620; Fehr/Gintis 2007) differs fundamentally from reciprocal behavior of the trustee in isolated encounters (‘one-shot games’) that is based on other-regarding preferences (‘strong reciprocity’). In this contribution, we do not address trust in isolated encounters or, more generally, one-shot problematic situations (see, e.g., the special issue 27(1) from 2005 of *Analyse & Kritik* on Fehr’s work). Snijders 1996 presents experimental evidence on trust in one-shot Trust Games.

formation can be obtained from past interactions of trustor and trustee, i.e., through dyadic embeddedness. Given network embeddedness, information can also be obtained from third parties who have interacted with the trustee in the past. If a trustee has been trustworthy in past interactions, a trustor might be more convinced that the trustee will be trustworthy again than if information on untrustworthy behavior of the trustee in the past has been revealed. Table 1 summarizes our distinction between dyadic and network embeddedness as well as between learning and control (Buskens/Raub 2002; see Yamagishi/Yamagishi 1994, 138–139 for a similar discussion of learning and control effects through network embeddedness).

Two mechanisms	Two types of embeddedness	
	Dyad	Network
Control	Sanctioning possibilities of the trustor without involving third parties.	Sanctioning possibilities of the trustor that involve third parties.
Learning	Information about the trustee from past experiences of the trustor.	Information about the trustee from third parties.

Table 1: Types of embeddedness and mechanisms through which embeddedness affects trust

1.3 Theory and Hypotheses on Control Effects of Embeddedness⁸

The infinitely repeated Trust Game (e.g., Kreps 1990) is an example of a simple theoretical model that allows for deriving hypotheses on control effects of embeddedness. In this model, the Trust Game is played repeatedly in rounds 1, 2, ..., t , ... More precisely, after each round, another round is played with continuation probability w ($0 < w < 1$), while the repeated game ends with probability $1 - w$. The continuation probability w represents Axelrod's (1984) 'shadow of the future': the larger w , the more an actor's payoff from the repeated game depends on what the actor receives in future rounds and thus the more important future rewards and punishments by the trustor are for the trustee relative to his current payoffs. One can then show that always placing trust and always honoring trust is an equilibrium outcome—and can in this sense be a result of rational behavior—if players value future payoffs high enough and the continuation probability is high enough, with the equilibrium strategy of the trustor being 'conditional' in the sense that she rewards trustworthiness of

⁸ In this and the following sub-section, we provide (very) rough sketches of various formal models, disregarding details and 'technicalities'. Note, too, that many of the results generalize in principle to a broad class of games that can be used to model problematic social situations other than trust problems (see Buskens/Raub forthcoming for references on this issue). E.g., the models discussed in the early *Analyse & Kritik*-contribution by Kliemt/Schauenberg 1982 are variants, including n -person variants, of the model for the infinitely repeated Trust Game.

the trustee through own future trustfulness, while abuse of trust is punished through not being trustful in at least some future rounds.⁹ More precisely, $w \geq (T - R)/(T - P)$ is a necessary and sufficient condition for being trustful and trustworthy in each round to be an equilibrium outcome. This condition requires that the shadow of the future is large enough compared to $(T - R)/(T - P)$, a convenient measure for the trustee's temptation to abuse trust. Assume now that trustfulness and trustworthiness become more likely when the condition becomes less restrictive.¹⁰ This leads directly to testable hypotheses on control effects through dyadic embeddedness. Specifically, one would expect that trustfulness and trustworthiness increase in the shadow of the future w and decrease in the temptation $(T - R)/(T - P)$ for the trustee.

Models of repeated Trust Games can be extended to account for control effects due to network embeddedness in addition to dyadic embeddedness. In these extended models (e.g., Weesie/Buskens/Raub 1998; Buskens/Weesie 2000a; Buskens 2002, chapter 3; see Raub/Weesie 1990 for a related model of network embeddedness for the Prisoner's Dilemma), the trustee interacts with a set of trustors, while the trustors are connected through a network that allows for communication about the behavior of the trustee. Next to direct reciprocity exercised by the trustor who interacts herself with the trustee in the focal Trust Game, network embeddedness allows for indirect reciprocity exercised by other trustors. Again, one can study equilibria such that trustors are 'conditionally' trustful, namely, depending on trustworthiness of the trustee in previous interactions, including interactions with other trustors. In addition to hypotheses on how trust is affected by the shadow of the future and the short-term incentives of the trustee, such models allow for deriving hypotheses on effects of network characteristics. Specifically, trustfulness and trustworthiness increase in the density of the network of trustors as well as in the trustor's outdegree, i.e., her probability to transmit information to other trustors who interact with the trustee. This is intuitively plausible since network density as well as outdegree increase the sanction possibilities of the trustor. Hence, if the trustee considers the long-term consequences of his behavior, higher network density and outdegree allow for placing and honoring trust even if the trustee's short-term incentive to abuse trust is fairly large.

A problematic assumption of these models for effects of network embeddedness is that information is reliable and that incentive problems associated with

⁹ Other forms of rewards and punishments are excluded in this simple scenario. Obviously, one could model reward and punishment options in other ways. In the Trust Game, one could add options for 'direct' sanctions by the trustor after the trustee has honored or, respectively, abused trust rather than sanctions through behavior of the trustor in future games. See, e.g., Fehr/Gintis 2007 for overviews of models that include such sanction possibilities in a focal problematic social situation itself and empirical evidence indicating that such sanction possibilities affect behavior in non-repeated problematic social situations quite dramatically. Again, models assuming other-regarding preferences can be used to account for those effects in non-repeated games. In the indefinitely repeated Trust Game, in contrast, assumptions on other-regarding preferences are not needed.

¹⁰ Such an assumption allows for comparative statics analyses and is crucial in deriving testable hypotheses. Many empirical applications of game theory involve similar assumptions explicitly or—more often—implicitly.

the supply of information are negligible (see, e.g., Lorenz 1988; Raub/Weesie 1990, 648; Williamson 1996, 153–155; Blumberg 1997, 208–210; Buskens 2002, 18–20). Supplying information on the trustee's behavior, though, is a contribution to a public good, namely, enforcing trustworthy behavior of the trustee. Such contributions are problematic: after all, public good production is itself a problematic social situation when contributions are costly (this feature is a major problem of institutions such as eBay's feedback forum; see, e.g., Bolton/Ockenfels 2006). Moreover, information from third parties can be inconsistent with own experiences. Also, information from third parties can be problematic due to misunderstanding or strategic misrepresentation: imagine that the trustors are competitors who purchase the same goods from the same seller. In a nutshell, one would expect that effects of network embeddedness are attenuated when such problems become more serious. Notice, too, that we have focused on the case of network control in the sense that other trustors can sanction the trustee in future interactions. This is control through 'voice' in Hirschman's (1970) sense. A different case of network control is that a trustor has access to alternative trustees and can exercise control through 'exit': whether or not the trustor interacts again with the trustee in the future depends on the trustee's behavior in the focal Trust Game. Modeling network control through exit opportunities for the trustor is not trivial (see Hirshleifer/Rasmusen 1989; Schüßler 1989; Vanberg/Congleton 1992 for related models) but one would expect in general that the likelihood of placing and honoring trust increases in the trustor's exit opportunities.

1.4 Including Theory and Hypotheses on Learning Effects of Embeddedness

Up to now, we have assumed (repeated) games with complete information. Specifically, trustors are completely informed on the behavioral alternatives and the incentives of the trustee. Hence, there is no need—and no opportunity—for trustors to learn during the (repeated) game about unobservable characteristics of the trustee. This means that these models do not yield hypotheses on learning effects of embeddedness.¹¹

Hypotheses on control as well as learning effects can be derived from models of games with incomplete information. Typically, these are models of finitely repeated games. Assume that there is a positive ex ante probability π that the trustee actually has no incentive to abuse trust in the Trust Game, i.e., his payoff from abusing trust is $T^* < R$ (an alternative assumption leading to essentially the same results would be to assume that with probability π the trustee has no opportunity to abuse trust). For example, a supplier has internalized norms of honest business behavior so that abusing trust would be associated with sufficient disutility due to 'internal sanctions.' The trustor knows the probability π but

¹¹ One might argue that learning is still possible in these models, since there are many equilibria and it is not clear why actors should choose the same equilibrium to start with. We disregard this issue, assuming that actors coordinate instantly on the same equilibrium (see, e.g., Fudenberg/Levine 1998, 20).

cannot directly observe the trustee's payoff from abusing trust. If the trustor is not trustful, she receives P , while her expected payoff from trustfulness is $\pi R + (1-\pi)S$. Therefore, in the one shot Trust Game, the trustor's unique equilibrium strategy is not to be trustful if $\pi < (P - S)/(R - S)$. Conversely, being trustful is her unique equilibrium strategy if $\pi > (P - S)/(R - S)$. Note that $(P - S)/(R - S)$ is a convenient measure of the risk of being trustful. Assume now that trustor and trustee play the Trust Game with incomplete information N times. This is basically the scenario of a finitely repeated game in Camerer and Weigelt (1988), Dasgupta (1988), Bower, Garber, and Watson (1997), and Buskens (2003). Now, if the trustor is trustful in some round that is not the final round, trust may be honored for one of two very different reasons. First, the trustee's payoff could indeed be $T^* < R$ so that there is no incentive at all for the trustee to abuse trust. Second, the trustee's payoff could be $T > R$ but the trustee follows an incentive for reputation building. The trustee knows that if he abuses trust, the trustor can infer for sure that the trustee's payoff from abusing trust is $T > R$ and may thus never be trustful again in future rounds. This is due to a backward induction argument. Knowing the trustee's incentive, equilibrium behavior now clearly requires that there will be no trust in the final round. However, this means that behavior in the last but one round cannot have effects on behavior in the final round. Hence, there will be no trust in the last but one round and so forth. On the other hand, if the trustee honors trust, the trustor remains uncertain about the trustee's incentives and may be trustful again in the future. Conversely, the trustor can anticipate on such behavior of the trustee and may therefore be inclined to indeed be trustful. In the finitely repeated Trust Game with incomplete information, the trustor can control the trustee in that trustfulness in future rounds depends on trustworthiness in the current round and the trustor can learn about the incentives of the trustee from the trustee's behavior in previous rounds. The result is a subtle interplay of a trustor who tries to learn about and to control the trustee, taking the trustee's incentives for reputation building into account, and a trustee who balances the long-term effects of his reputation and the short-term incentives for abusing trust, taking into account that the trustor anticipates on this balancing.

The finitely repeated Trust Game with incomplete information has a (sequential) equilibrium involving trust in some rounds. More precisely, in that equilibrium, the game starts with trustfulness and trustworthiness in a number of rounds. Afterwards, a second phase follows in which the trustor and the trustee with $T > R$ randomize their behavior until the trustor does not trust or the trustee abuses trust. Thereafter, the third and last phase starts in which there is no trust until the end of the game. In the equilibrium, learning occurs—in the sense that the trustor updates her belief about the probability that she is playing with a trustee without an incentive to abuse trust—if trust is abused and in the second phase as long as trust is honored. Learning is rational in the sense of Bayesian updating. The first phase of the game with trustfulness and trustworthiness is shorter, the higher the risk $(P - S)/(R - S)$ for the trustor, the smaller the number of rounds of the repeated game, and the smaller the ex ante probability π that a trustee has no incentive to abuse trust.

Game-theoretic models with incomplete information such as the finitely repeated Trust Game are complex. They become even more complex by including learning due to network embeddedness. A shortcut linking learning effects of network embeddedness to such models is to assume that the trustor's ex ante probability π of interacting with a trustee who would never abuse trust depends on information the trustor receives from third parties such as other trustors who played Trust Games previously with the trustee. Specifically, based on information diffusion models in networks of trustors (e.g., Buskens 2002, chapter 4) and assuming that the information about the trustee is positive (it is information that the trustee has honored rather than abused trust), one would expect that the ex ante probability π increases in the density of the network of trustors as well as in the extent to which the trustor in the focal Trust Game receives information about the trustee from other trustors, i.e., increases in the trustor's indegree.

A more explicit game-theoretic model of network effects in games with incomplete information has been provided by Buskens (2003). In that model, the trustee plays Trust Games with two different trustors A and B . With some probability, each trustor can inform the other trustor on the trustee's previous behavior. We can conceive of the probability that trustor A transmits information to trustor B as A 's outdegree and B 's indegree (and vice versa). Thus, trustor A controls the trustee through her outdegree and learns from B about the trustee through her indegree. If each trustor transmits information to and receives information on the trustee from the other trustor with sufficiently high probability, the first phase of the repeated game with trustfulness and trustworthiness becomes longer and in this sense network embeddedness increases trust.

Summarizing and relying on similar comparative statics arguments like outlined above, the results of the game-theoretic models for learning and control effects through dyadic and network embeddedness yield the hypotheses that trustfulness and trustworthiness decrease in the trustor's risk $(P - S)/(R - S)$, increase in the remaining number of rounds to be played ('shadow of the future'), and increase if the trustor's previous experiences with the trustee are positive (the trustee has been trustworthy) rather than negative (the trustee has abused trust). Furthermore, assuming that the trustor receives positive information about the trustee from other trustors, trustfulness and trustworthiness increase in the density of the network of trustors, and in the trustor's indegree.

Models for control and learning effects of embeddedness in games with incomplete information use very strong assumptions on the actors' rationality (in the sense of sequential equilibrium), including rational (Bayesian) updating of beliefs. A further problem of these models is that they neglect learning on other features than unobservable characteristics of the trustee. For example, a trustor could try to use information she receives from other trustors for inferring how to reasonably cope with trust problems. In addition, the trustee might likewise try to learn, for example in the sense of trying to infer from past experience how trustors use their sanction opportunities (see Buskens/Raub/Van der Veer 2008 for some work in this direction). Also, past interactions may give rise to

other effects than exclusively learning. For example, actors may have pledged investments in their relation through past interactions and these investments affect the incentives in the focal Trust Game (we will return to this issue below).

Therefore, the attractive feature of game-theoretic models involving incomplete information is that control and learning can be analyzed simultaneously, while the price tag of these models is a set of rather strong assumptions on the actors' rationality. Alternatives are 'pure' learning models in which actors adapt their behavior based on past experiences. Actors try to optimize short-term outcomes, while not (or 'hardly') looking ahead. This implies, too, that actors do not take other actors' incentives into account (see Fudenberg/Levine 1998 and Camerer 2003, chapter 6, for a useful overview of learning models and Buskens/Raub/Van der Veer 2008 for an application to the finitely repeated Trust Game). Hence, these models neglect control effects. Typically, learning models yield hypotheses that trustfulness decreases in the trustor's risk $(P - S)/(R - S)$. Also, the trustor's estimation of the probability π that the trustee does not have an incentive to abuse trust will typically increase with positive information about the trustee's behavior in previous interactions, be it information from the trustor's own previous interactions with the trustee or information from third parties. Therefore, one would again hypothesize that more positive information increases trustfulness.

A summary of the hypotheses on learning and control effects of dyadic embeddedness and network embeddedness on trustfulness and trustworthiness is provided in Table 2.

Two mechanisms	Two types of embeddedness	
	Dyad	Network
Control	1. Trustfulness and trustworthiness decrease with the trustee's temptation and increase with the shadow of the future.	3. Trustfulness and trustworthiness increase with the density of the trustor's network and her outdegree.
Learning	2. Trustfulness and trustworthiness decrease with the trustor's risk and increase (decrease) with positive (negative) experiences with a trustee.	4. Trustfulness and trustworthiness increase with the density of the trustor's network and her indegree (given that information about the trustee is predominantly positive).

Table 2: Hypotheses on embeddedness effects on trust

2. Empirical Evidence on Embeddedness Effects

A rather sizable literature offering empirical research on trust problems and, more specifically, on embeddedness effects on trust is meanwhile available. There is much experimental literature on trust problems as modeled by the Trust Game and closely related variants (see Camerer 2003, chapters 2.7 and 8.3 for overviews) and there is much empirical research on embeddedness effects on trust, partly experiments but also much field research in economic sociology (see Buskens/Raub forthcoming for an overview; see Cook/Cooper 2003 for an overview of experimental studies on how other elements in the social context than embeddedness characteristics on which we focus here can affect trust). A characteristic feature of much of the literature on embeddedness effects on trust is, though, that it offers broad evidence for effects of dyadic embeddedness and network embeddedness, while it is hardly ever the case that we can determine whether the effects are due to learning, control, or a combination of the two mechanisms. Thus, analysis of the mechanisms through which embeddedness works is often lacking (see Buskens/Raub 2002, 179–180 for a number of examples).

We now briefly summarize some of our own empirical studies on embeddedness effects.¹² These studies have been inspired by two aims. One aim is to disentangle different mechanisms through which embeddedness affects trust. The other aim is to use alternative and complementary research designs—survey research, vignette studies, and lab experiments—for testing similar, if not the same, hypotheses, thus employing a strategy sometimes referred to as ‘triangulation’ or ‘cross validation’ and hopefully providing cumulative evidence on the robustness of findings (see Harrison/List 2004; Levitt/List 2007 for a thorough discussion of this issue).

Each research design has its own typical advantages and disadvantages. For example, survey studies are on actual interactions outside the lab and are thus less problematic with respect to external validity. However, they are often less closely related to the underlying theoretical model and require additional and often hard-to-test assumptions in order to be able to use them as evidence for or against implications from the underlying theoretical model, they often allow for only rather imperfect measurements of core variables, control over the variation in core independent variables is often problematic, and the causal relation between variables is often problematic. Lab experiments can be designed so that they closely represent model assumptions, they allow for providing proper incentives for subjects, for control over variation in core independent variables, and the causal relation between manipulations and outcome differences is mostly obvious. A disadvantage is that experimental set-ups are often rather artificial. Subjects

¹² These studies have been designed and executed as part of a research program on trust and cooperation in different kinds of social and economic relations (on this program, see Raub/Weesie 2000). We provide rough summaries of the studies, neglect many details, and refer in each case to representative publications for more detailed information and discussion. The program has generated a number of further studies in addition to those covered here (see Blumberg 1997; Prosch 1999; Gautschi 2002; Barrera 2005; Vogt 2007).

are typically students who are engaged in abstract interactions. This questions external validity. Vignette studies are less abstract than lab experiments, while still allowing for control over variation in core independent variables. However, they typically involve hypothetical decisions in hypothetical situations and ‘incentive compatibility’ is problematic. It thus seems that it makes sense to test hypotheses repeatedly with different designs, each having specific strengths and shortcomings, in order to assess the robustness of empirical results.

2.1 A Survey Study on Buyer-Supplier Relations

We first sketch a large-scale survey study on the purchase of information technology (IT) products (hard- and software) by Dutch small- and medium-sized enterprises (SMEs; 5-200 employees; see Batenburg/Raub/Snijders 2003; Buskens/Raub/Weesie 2000; Rooks/Raub/Tazelaar 2006 for representative publications). In this study, key informants of the buyer firms, typically the IT-managers who were responsible for the purchase, provided information on the purchase of an IT-product, using a structured questionnaire. The study was conducted in 1995 and comprises data from 788 buyer firms. About 25% of the respondents were willing to provide information also on a second purchase of an IT-product, sometimes from the same, sometimes from a different supplier. This yielded data on $788 + 183 = 971$ transactions. In 1998, the buyers were contacted again and data on another 281 transactions have been collected. The complete data set thus comprises $971 + 281 = 1252$ transactions. Compared to other surveys among organizations, response was high and non-response analysis shows that the response group is not biased on core firm characteristics such as size, industry, or region. In addition, we know that firms in the sample do not differ from the non-response group in their general satisfaction with IT-suppliers. It is thus unlikely that the data set is biased towards firms that have on average very many or very few problems with IT-suppliers.

We conceptualize an IT-transaction as a variant of a Trust Game, with the buyer in the role of the trustor and the supplier in the role of the trustee.¹³ We thus focus on ex post problems associated with a transaction such as delayed delivery, inferior quality of the product, and insufficient service provided by the supplier. The survey allows for measuring (lack of) trustfulness of the trustor through the investments of the trustor in the ex ante management of the transaction. This refers to investments of the buyer in negotiating and contracting with the supplier such as the number of person days of employees of the buyer that have been involved in negotiating and contracting, the number of departments of the buyer that have been involved, the use of external legal advisors, the use of a standard contract or a tailor made contract, and, finally, the number of financial and legal clauses as well as technical specifications that have been addressed during the negotiations or that are included in the contract. Such ex

¹³ We thus neglect that buyer-supplier relations often provide incentives for opportunistic behavior of the buyer, too, such as delayed payment. We also neglect that the buyer may suffer not only from opportunistic behavior of the supplier but also from contingencies such as force majeure or from incompetence (rather than opportunism) of the supplier.

ante management of the transaction reduces the incentives of the supplier for opportunistic behavior and likewise reduces the damage for the buyer in case of supplier opportunism. For example, ex ante management of the transaction yields contractual agreements on compensation for the buyer in case of delivery delays or quality problems. At the same time, however, ex ante management is associated with costs in terms of time and money for the buyer. Thus, the assumption is that the less the buyer trusts the supplier, the more she will invest in ex ante management.

The measurement of (lack of) trustworthiness of the supplier uses ex post problems after the transaction. Examples of indicators in the survey for such ex post problems are delivery delays, exceeding the agreed upon price or budget, various quality problems, and after sales problems such as insufficient support or service.

Independent variables related to the suppliers temptation for behaving opportunistically as well as the buyer's risk associated with the transaction are transaction characteristics such as the volume of the transaction, the ex ante monitoring problems of the buyer with respect to the quality of the product, the switching costs for the buyer in case the product had to be replaced, and the importance of the product for the buyer, e.g., in terms of the buyer's profitability.

The survey includes various variables representing dyadic embeddedness of the transaction. With respect to previous experiences of the buyer with the supplier, respondents have been asked whether there had been previous business with the supplier and, if so, how satisfied they were with previous business with the supplier. Information on the shadow of the future is available through a question that taps the buyer's expectations, at the time of the focal transaction, for the frequency and size of future business with the supplier.

Finally, the survey allows for measuring network embeddedness of the transaction. First, information is available on the buyer's network with other clients of the supplier, i.e., the buyer's voice network. More precisely, the survey includes an indicator for the degree of the buyer in the sense of the number of other clients of the supplier whom the buyer knows. Furthermore, an indicator is available for the density of contacts between firms in the buyer's sector of industry. Another indicator for the density of the network in which the transaction is embedded is the geographical distance between the municipalities in which buyer and supplier are located, assuming that the buyer will typically have more contacts with other buyers of the supplier and that these other buyers will have more contacts among themselves when buyer and supplier are located closer together. Finally, the opportunities for voice of buyers are indicated by a survey question on the visibility of the supplier in the market. Notice that each of these network variables is related to the buyer's opportunities for learning as well as control through network embeddedness. Hence, these variables do not allow for disentangling network learning and network control effects. In addition to indicators for the buyer's voice network through contacts with other buyers, there are indicators available for the buyer's exit network. These include the number of potential suppliers the product as well as the number of alternative products.

These indicators are clearly related to the buyer's opportunities for controlling the supplier through network embeddedness.

In addition, the survey provides information that allows to control for variables such as the size of buyer and supplier firm, in-house legal expertise available in the buyer firm, etc.

It is useful to note that the design of the survey and the measurement of (lack of) trustfulness imply a somewhat complex hypothesis on the control effect of dyadic embeddedness. This is due to the fact that, assuming rational behavior of buyer and supplier, a larger shadow of the future in the sense of expectations of more frequent and more extensive future business between buyer and supplier has two opposite effects on the buyer's investments in ex ante management of the focal transaction. On the one hand, costly investments in ex ante management are less necessary for the buyer if the shadow of the future is larger because of her larger sanction potential. On the other hand, however, a larger shadow of the future makes investments in ex ante management of the focal transaction also more worthwhile. After all, these investments can be used again in subsequent transactions. For example, the contract for the focal transaction can be reused for future transactions. This is an investment effect due to the expectation of future business. The driving force of this effect is that investments in ex ante management of the focal transaction affect the incentive structure of future transactions. Taking both effects of the shadow of the future on (incentives for) investments of the buyer in ex ante management into account, it is unclear what the main effect of the shadow of the future will be. However, a negative interaction effect of previous business with the supplier and the shadow of the future is expected, since the investment effect will be larger in initial transactions that are not preceded by previous transactions with the same supplier (see Raub/Snijders 2001 for theoretical modeling on this issue).

2.2 A Vignette Study on Buyer-Supplier Relations

We now outline a second study (see Rooks/Raub/Selten/Tazelaar 2000 for a representative publication) on how embeddedness affects trust. In important respects, this study parallels the large-scale survey. The study focuses again on buyer-supplier relations and on the buyer's investments in ex ante management of transactions. Various variables representing transaction characteristics and the embeddedness of the transaction closely resemble variables from the survey. Thus, the same or at least very similar hypotheses can be tested. However, the second study is a vignette study and thus employs a very different design.

In this study, subjects are purchase managers of Dutch medium-sized and large companies. The managers are presented with hypothetical transactions and are requested to imagine that these 'vignettes' are actual transactions from their daily business practice. Subjects then answer questions about their behavior related to these transactions (see, for example, Rossi and Nock 1982 on vignette experiments). Once again, we conceptualize a transaction as a trust problem with the buyer in the role of the trustor and the supplier in the role of the

trustee. The study comprises data from 40 managers who provided judgments on 348 vignettes, 8–10 per respondent.

A vignette consists of a description of a transaction for which eight variables are varied. Three variables are related to transaction characteristics and can be used as indicators for the supplier's temptation for opportunistic behavior and the buyer's risk associated with the transaction. These variables include the volume of the transaction, the extent to which the buyer is able to judge the quality of the product at the time of the transaction, and the extent to which the buyer needs to make specific investments for the implementation of the transaction. Note that these variables are closely related to the transaction characteristics measured in the survey: Both studies comprise a variable measuring the volume of the transaction, variables measuring the buyer's monitoring problems, and variables measuring specific investments, operationalized in the survey as switching costs.

The fourth and fifth variable represent dyadic embeddedness and describe the bilateral relation between the buyer and the supplier. One of these variables indicates whether the buyer and supplier have done business before with one another and how satisfactory or problematic earlier transactions with the supplier have been. This variable represents learning through dyadic embeddedness. The other variable indicates whether buyer and supplier expect to do more business in the future. Clearly, this variable represents control opportunities through dyadic embeddedness. The sixth and the seventh variable at the vignettes are related to the network of the buyer. A degree variable refers to the extent to which the buyer knows other business partners of the supplier. This variable represents learning as well as control through network embeddedness. Another variable refers to exit opportunities of the buyer through describing the extent to which the buyer has access to alternative suppliers for purchasing a similar product. This variable represents control through network embeddedness. Note that the variables representing dyadic embeddedness and network embeddedness are close analogues of the respective variables in the survey on buyer-supplier relations. An additional variable in the vignette study indicates the country in which the supplier is located. This is an indicator for 'institutional embeddedness' of the transaction and the underlying idea is that trust is more problematic when the supplier comes from a different institutional setting. The design of the study allows furthermore to control for respondent characteristics such as the years of experience as a purchase manager and for the degree to which a vignette resembles the daily practice of the respondent.

The dependent variable in this vignette study are investments in the ex ante management of the transaction described on the vignette, closely paralleling the respective variable in the survey. Just like in the survey, (lack of) trust of the buyer is measured through such investments. More precisely, subjects were asked how much time they would invest in negotiations and contracting for the transaction, and which departments of their own company would be involved in these negotiations. Note that this conceptualization of trust allows for again testing the hypothesis on the control effect of dyadic embeddedness as an interaction effect of previous business of the buyer with the supplier and

the shadow of the future. Note, too, that this vignette study does not include information on actual supplier behavior associated with the execution of the transactions described on the vignettes. Thus, this study does not allow for testing hypotheses on embeddedness effects on trustee behavior.

2.3 A Vignette Study on Buying a Used Car

In a second vignette study (see Buskens/Weesie 2000b for a representative publication), we address a, if not the, classic example of a trust problem in economic exchange: buying a used car (Akerlof 1970). In this study, students are asked to compare pairs of situations for buying a used car, while properties of the relation between the buyer and the car dealer are varied. Thus, in this study, students are assumed to be in the role of the trustor, while the dealer is assumed to be in the role of the trustee. There are a number of important differences between the two vignette studies. The type of transaction is clearly different. In the first study, subjects rate vignettes by indicating the level of investments in negotiations and contracting, while in the second study subjects compare different vignettes rather than providing ratings. In the first vignette study, subjects are purchase managers with considerable experience in the type of transactions discussed in the experiment, while in the second study the subjects are students. In the first vignette study, transaction characteristics are varied, while they are kept constant in the second study. In the first vignette study, learning and control through network embeddedness in the sense of contacts with other buyers are not explicitly distinguished, while the second study provides an attempt to do so.

In the second vignette study, students are asked to compare situations for buying a used car. The students have been presented with pairs of vignettes describing such a transaction and subsequently stated their preference for one vignette within each pair. The preference for a vignette is assumed to indicate that the buyer trusts the respective dealer more. The study does not provide information on actual behavior of the dealer associated with the execution of the transactions described on the vignettes. Thus, this study again does not allow for testing hypotheses on embeddedness effects on trustee behavior. The experiment was held in the U.S. (Chicago) and the Netherlands (Utrecht and Tilburg). The study comprises data from 125 subjects on 1249 comparisons of pairs of vignettes, i.e., 10 comparisons per subject.

Six variables are varied at the vignettes. The first variable indicates the price of the car (U.S.\$1000 or U.S.\$4000). Within each pair of vignettes between which subjects had to choose, the price of the car is held constant. Consequently, the price cannot have a direct effect on the choices made by the subjects, but it might be the case that some embeddedness variables are more important for cheap cars than for expensive cars. In other words, the volume variable is added only to allow for testing interaction effects of the size of the trust problem and embeddedness variables.

Five other variables represent embeddedness characteristics. Whether the buyer has bought a car from the dealer before and was satisfied, or did never buy

a car from the dealer, represents dyadic learning. Control opportunities of the buyer at the dyadic level are operationalized as whether or not the buyer expects to move to the other side of the country soon. Control is more difficult for a buyer if she moves to the other side of the country and the shadow of the future is thus smaller. Moreover, the probability that the buyer has future transactions with the dealer is smaller if the buyer moves. A problem with the operationalization is that if a buyer moves, the possibilities of control through the network also become smaller. Note that, other than in the previous two studies on buyer-supplier relations, the trust of the buyer in the present transaction does not affect the incentive structure of future transactions (in this sense, the design of this study approximates the models of repeated Trust Games as sketched in section 1 more closely than the two previous studies on buyer-supplier relations). Hence, based on rational choice assumptions, one now does predict a straightforward main effect of the shadow of the future on the likelihood that a dealer is preferred.

Concerning network embeddedness, a density variable differentiates between a dealer whose garage is or is not well-known in the neighborhood of the buyer. If more potential customers in the neighborhood know the dealer, the buyer probably knows more other customers and it is likely that there are more ties among these other customers. Therefore, learning about as well as control of a well-known garage through the network of customers can be more effective than learning about or control of a garage that is not well-known. Third-party information is operationalized as whether or not the buyer has information from friends about transactions of these friends with the garage. This variable represents learning through network embeddedness. Finally, the design of the study includes a degree variable, operationalized as whether or not both the buyer and the dealer are members of the same sports team. This is a measure for the buyer's degree in the sense that the number of acquaintances the buyer and dealer have in common is expected to be larger if the buyer and dealer are members of the same sports team. Common membership provides the buyer with possibilities of controlling the dealer through reputational sanctions both in his business and as a team member. These sanctions can include discouraging others to buy from the dealer, but also social sanctions during activities at the sports team. A rational dealer should be concerned about these sanction opportunities of the buyer. Note that this effect of common membership may be smaller if the buyer expects to move to the other side of the country (our variable representing the shadow of the future at the level of the dyad). In the formulations used for describing possible values of the degree variable, nothing about past behavior of the dealer was mentioned, so as to prevent the possible effect of the variable being interpreted as learning. Of course, the buyer who shares membership in a sports team with the dealer also has a better potential for learning about the dealer's behavior, but given that the social setting allows for rather extensive social sanctions and the fact that there is no indication whether information would be positive or negative, the control interpretation seems predominant for this variable. Another problem with this operationalization is that there may also be a group of buyers who are reluctant to buy a car from a team member. The relationship between the team members may be spoiled if the car happens

to have a defect. Moreover, if it is not very obvious that an acquaintance has acted untrustworthy, it is questionable whether a buyer will actually execute sanctions against this acquaintance because the costs of sanctions for the buyer herself are probably relatively high. Obviously, this would make a dealer *less* attractive if he is a team member, and would therefore reduce the theoretically predicted degree effect.

2.4 An Experiment on Embeddedness Effects in Finitely Repeated Trust Games

Our final study is an experiment employing a design that closely reproduces a finitely repeated Trust Game (see Buskens/Raub/Van der Veer 2008 for detailed information and discussion; see Barrera/Buskens forthcoming for a more complex experiment testing similar hypotheses). In this experiment, Trust Games are played in triads comprising two trustors and a trustee. In the experiment, the outcomes of the Trust Games are points that subjects earn. If the trustor is not trustful, this yields 10 points for both trustor and trustee; when trust is honored, each actor receives 20 points; when trust is abused, the trustee receives 40 points, leaving the trustor with no points (see the right-hand Trust Game in Figure 1). Subjects are paid 1 eurocent for each point they earn at the end of the experiment. Subjects play the Trust Game in supergames of 15 rounds. Subjects are matched in groups of three, one trustee and two trustors, which we call triads. Clearly, a triad represents a small network between the subjects. In each of the 15 rounds, the trustee plays one Trust Game with each of the two trustors. During the 15 rounds, the trustee plays with the same two trustors in each round. First, one of the trustors, say, trustor 1, plays a Trust Game with the trustee. After this Trust Game has been finished, the other trustor, trustor 2, plays a Trust Game with the same trustee. This pair of two games is played 15 times. Therefore, in every round, while trustors play one Trust Game, the trustee plays two Trust Games, adding to 30 Trust Games played per supergame by one trustee. The trustee not necessarily needs to make a choice in all 30 games: when the trustor does not trust, the trustee has no choice to make.

In every round, the trustee always plays with the same trustor first, while the other trustor has to wait, and always plays second with this trustee. Thus, within a supergame, the trustors always move in the same order. All subjects, trustors and trustee, have complete information about the whole structure of the game such as the number of rounds to be played, the payoff function of trustors and trustee, etc. The experiment employs two information conditions. In both conditions, the trustee is immediately informed on the trustor's move in the current Trust Game. Between conditions the amount of information is varied that is shared among the two trustors playing with the same trustee. In the 'no information exchange between trustors' condition, trustors do not share any information: each trustor only knows what happens in her own Trust Games with the trustee but is not informed about what happens in the games of the other trustor playing with the same trustee. In the 'full information exchange

between trustors' condition, trustors playing with the same trustee do share all information about each other's games. In this condition, as soon as a game has been played, either the first or the second game in the round, both trustors receive information on the choices made in this game. Information is provided automatically via networked computers and is always truthful. All subjects know in what information condition they are and thus also know what information is available to the other two actors in their triad.

Every subject played three times a supergame as described above, once as a trustee, once as trustor 1, and once as trustor 2. Each subject played all three supergames in the same information condition. In between the three supergames, the subjects were rematched to other subjects. Subjects were never rematched to other subjects they already played with in a previous supergame. This was made common knowledge to all subjects.

The information about the structure of the experiment such as the number of rounds, roles (i.e., being trustor or trustee), and what subjects would get to know was honestly provided and subjects were never deceived or in another situation than told. In order to prevent inducing normative associations, the names of the different roles and their possible moves were rendered neutrally. For instance, the moves of the trustee were labeled 'down' and 'right' rather than 'honor trust' and 'abuse trust'.

In total, 72 subjects participated in the experiment, mostly undergraduate students from different fields, most of them students of social sciences. Four sessions were scheduled and 18 subjects participated in each session. Two sessions were played in the condition with no information exchange between trustors and two sessions in the condition with full information exchange. With four sessions, six triads per session, and three supergames of fifteen rounds per subject, each round comprising two Trust Games, $4 \times 6 \times 3 \times 15 \times 2 = 2160$ Trust Games were played in total. Trustee behavior is observed only in those games in which the trustor is trustful. There are 485 games in which there was no trust, leaving 1675 games (78% of the total number of games played) in which the trustee's behavior is observed.

This experiment can be used to study how trustfulness of the trustor and trustworthiness of the trustee depend on control opportunities of the trustor due to embeddedness. Dyadic control depends on the number of rounds left in the supergame (shadow of the future). Network control depends on the information condition. The experiment can be likewise used to study how trustfulness of the trustor depends on learning of the trustor about the trustee through embeddedness. Dyadic learning of the trustor results from behavior of the trustee in previous rounds of the game with that trustor. Network learning results from information—if any—the trustor receives on behavior of the trustee in previous rounds vis-à-vis the other trustor. Note that payoffs do not vary between the Trust Games so that effects of the trustee's temptation and the trustor's risk on trustfulness and trustworthiness cannot be studied in the experiment.

The four studies complement each other in employing alternative research designs for testing hypotheses on embeddedness effects. They are also cumulative in the sense that disentangling specific embeddedness effects from each other is

	Survey	Vignette study 1	Vignette study 2	Lab experiment
Type of problematic social situation	Buyer-supplier transactions (TAs)	Buyer-supplier TAs	Buying a used car	Trust Games (TGs)
Respondents/ subjects	IT-managers	Purchase managers	Students	Students
Number of firms/ respondents/ subjects	788	40	125	72
Number of observations	1252 TAs	348 vignettes/ TAs	1249 pairs of vignettes/ TAs	2160 TGs
<i>Dependent variables</i>				
Trustor	Investments in ex ante management of TAs	Investments in ex ante management of TAs	Choice between two dealers	Placing trust
Trustee	Performance	—	—	Honoring trust
<i>Independent variables</i>				
Temptation, risk	Various TA characteristics	Various TA characteristics	Price of the car	Payoffs not varied
Dyadic embeddedness				
Learning	(Satisfaction with) own previous TAs with supplier	(Satisfaction with) own previous TAs with supplier	(Satisfaction with) own previous TAs with dealer	Trustee behavior in own previous TGs
Control	Expected future TAs with supplier	Expected future TAs with supplier	Whether or not buyer expects to move	Rounds left in the supergame
Network embeddedness				
Learning	Degree, density, visibility of supplier	Degree	Third-party information, density	Trustee behavior in previous TGs with other trustor
Control	Degree, density, visibility of supplier, exit opportunities	Degree, exit opportunities	Density, degree	Information condition
Other (control) variables	Size of buyer and supplier firm, in-house legal expertise of buyer, etc.	Respondent characteristics: experience, etc.	Not applicable	Timing within the experiment

Table 3: Overview of the empirical studies

typically easier in some studies than in others. This indicates that (and why) it may be useful to conceive ‘quantitative analysis of data’ more broadly than in Goldthorpe’s (1996) original proposal. Table 3 provides a summary and overview of the studies.

2.5 Summary of Findings on Embeddedness Effects

We now summarize findings on embeddedness effects, in a schematic way and disregarding details (see the representative publications mentioned above for additional information), from the four empirical studies. The findings are based on a variety of statistical models. Typically, alternative statistical models have been estimated for each study in order to assure the robustness of findings per study.

Effects of temptation and risk

First, the survey as well as the vignette study on buyer-supplier relations provide very consistent and strong evidence supporting the hypotheses that the trustee’s temptation for opportunistic behavior and the trustor’s risk are negatively related to the trustor’s trustfulness: investments in the ex ante management of transactions are larger for transactions that are associated with more temptation for the trustee (supplier) and more risk for the trustor (buyer). Moreover, the survey on buyer-supplier relations provides consistent and rather strong evidence that more temptation and risk also negatively affect the trustee’s trustworthiness: supplier performance is lower for transactions with more temptation and more risk. The consistent evidence on these effects and their strength have been a reason to focus more on learning and control effects proper in the other studies.

Effects of dyadic embeddedness and network embeddedness on trustor behavior

With respect to effects on trustfulness of the trustor, the studies provide consistent and rather strong evidence for learning effects through dyadic embeddedness. The survey and the vignette study on buyer-supplier relations both show that previous business with the supplier and positive experiences from previous business are associated with smaller investments in ex ante management of the focal transaction. In the vignette study on buying a used car, positive experience from a previous purchase has a strong positive effect on the likelihood that a dealer is chosen. Finally, in the lab experiment, the more a trustor’s trustfulness has been honored in the past by the trustee with whom the trustor plays a focal Trust Game, the more likely it is that the trustor is trustful in the focal Trust Game, while the more a trustor’s trustfulness has been abused in the past by the trustee with whom she interacts now, the less likely it is that the trustor is trustful now.

The evidence on learning effects through network embeddedness on trustor behavior is somewhat more mixed. First, it is not possible to disentangle learning and control effects through network embeddedness with respect to the buyer’s voice network, i.e., the buyer’s relations with other buyers, in the survey and

in the vignette study on buyer-supplier relations. There are almost no effects of such network embeddedness on investments of the buyer in ex ante management of transaction in the survey on IT-transactions, the only exception being one of the indicators for density, namely, geographical distance between the locations of buyer and supplier: as expected, a larger distance—indicating a less dense network of buyer and supplier and third parties such as other buyers—is associated with less trustfulness of the buyer. There is evidence from the vignette study on buyer-supplier relations that contacts of the buyer with other buyers have a positive effect on the buyer's trustfulness but this effect can be interpreted as a learning as well as a control effect of network embeddedness. In the vignette study on buying a used car, both positive information on the dealer from other buyers as well as the density of the buyer network increase the likelihood that the dealer is chosen. Again, note that the density variable represents opportunities not only for learning but also for control through network embeddedness. In the lab experiment, information on how the trustee behaved in previous Trust Games vis-à-vis the other trustor in the triad does have an effect on trustfulness of the trustor and this clearly supports the respective hypothesis on learning effects of network embeddedness.

Next, we turn to evidence with respect to control effects of embeddedness on trustor behavior. Each of the four studies provides evidence that more dyadic control opportunities for the trustor have a positive effect on the trustor's trustfulness. In the survey on IT-transactions as well as in the vignette study on buyer-supplier relations we find the negative interaction effect of expected future and previous business with the supplier on investments of the buyer in ex ante management of the focal transaction. It is noteworthy that this theoretically expected interaction effect is found in both studies, while both studies employ very different designs for testing the respective hypothesis. In the vignette study on buying a used car as well as in the lab experiment we also find consistent evidence for the theoretically expected main effect of the shadow of the future on trustfulness of the trustor. In the vignette study on buying a used car, buyers who are about to move away from the dealer are less likely to choose that dealer for buying a used car. In the lab experiment, the number of rounds left in the supergame has a positive effect on the likelihood that the trustor is trustful.

Finally, while we have seen that there is quite some evidence on effects of network embeddedness on trustfulness through learning effects, there is only little evidence on network embeddedness effects on trustor behavior through control opportunities from network embeddedness. With respect to the survey on IT-transactions, we have already mentioned that the variables referring to ties of the buyer with other buyers can all be interpreted as representing learning as well as control opportunities through network embeddedness and that only one of those variables does have an effect. In addition, the survey on IT-transactions comprises information on the buyer's 'exit network', i.e., access to other suppliers and alternative products. Network embeddedness in this sense clearly allows for control of the supplier but the buyer's exit opportunities do not have an effect on investments in ex ante management of the focal transaction. In the vignette

study on buyer-supplier relations, we find some more evidence on control effects of network embeddedness on trustor behavior: contacts of the buyer with other buyers have a positive effect on the buyer's trustfulness (note once more, though, that this can also be interpreted as a learning effect of network embeddedness). Also, there is some evidence from this vignette study that better exit opportunities of the buyer reduce the buyer's investments in ex ante management of the transaction on the vignette. In the vignette study on buying a used car, we do find evidence that density of the buyer network as well as network control through joint membership of buyer and dealer in a sports team have a positive effect on the likelihood that the dealer is chosen. This does provide some support for hypotheses on control effects of network embeddedness on trustfulness of the trustor, with the proviso that both variables and certainly so the density variable may also represent learning opportunities through network embeddedness. Finally, there is no support in the lab experiment data for control effects on trustor behavior through network embeddedness. Below, we will come back to these findings.

Effects of dyadic embeddedness and network embeddedness on trustee behavior

Turning to embeddedness effects on trustee behavior, neither of the two vignette studies comprises information on trustee behavior in the focal transaction—or pair of transactions—represented at the vignettes. Only the survey on IT-transactions and the lab experiment provide evidence with respect to the respective hypotheses. We are interested in whether more control opportunities for the trustor through embeddedness do have a positive effect on trustworthiness of the trustee.

The evidence on control effects of dyadic embeddedness on trustee behavior is somewhat mixed. In the survey on IT-transactions one finds that the shadow of the future in the sense of expected future business does not have a positive effect on the supplier's trustworthiness in the sense of improved performance. On the contrary, a larger shadow of the future even has a negative effect on supplier performance. There are, however, some empirical indications that this effect could be due to problems related to the measurement of the variable that represents the shadow of the future in this study (see Rooks/Raub/Tazelaar 2006, 263). The evidence from the lab experiment is clear: control opportunities of the trustor through dyadic embeddedness as represented by the number of rounds left in the supergame do have a positive effect on trustworthiness of the trustee.

Finally, the data from the survey on IT-transactions reveal a positive effect of network embeddedness of the transaction on trustworthiness of the supplier in the sense of supplier performance. This is the case with respect to effects of the buyer's voice network as well as effects of the buyer's exit network and for all the variables representing network embeddedness. Moreover, there is clear evidence from the lab experiment that network embeddedness has a positive effect on trustworthiness of the trustee, since there is a clear effect of the information condition on trustee behavior.

	Survey	Vignette study 1	Vignette study 2	Lab ex- periment
Effects of temptation and risk on trustor behavior	Support	Support	No test	No test
Effects of temptation and risk on trustee behavior	Support	No test	No test	No test
<i>Dyadic embeddedness</i>				
Learning effects on trustor behavior	Support	Support	Support	Support
Control effects on trustor behavior	Support	Support	Support	Support
Control effects on trustee behavior	No support	No test	No test	Support
<i>Network embeddedness</i>				
Learning effects on trustor behavior	Hardly/no support	Support	Support	Support
Control effects on trustor behavior	Hardly/no support	Some support	Some support	No support
Control effects on trustee behavior	Support	No test	No test	Support

Table 4: Overview of evidence on hypotheses related to embeddedness effects from the empirical studies

The empirical evidence from the four studies is summarized in Table 4. We find consistent evidence for the hypotheses on effects of temptation and risk on trustor as well as trustee behavior, for the hypotheses on dyadic learning and control effects on trustor behavior, and for the hypotheses on network control effects on trustee behavior. Quite some, though not all evidence supports the hypotheses on network learning effects on trustor behavior and the hypothesis on dyadic control effects on trustee behavior. However, while we do find much evidence for network control effects on trustee behavior, there is very little evidence for network control effects on trustor behavior.

The latter pattern of findings—network control effects on trustee behavior but hardly, if at all, on trustor behavior—constitutes a challenge and arguably the major challenge that emerges from the results of the four studies. Buskens (2002, 152–161) provides various arguments and also some empirical evidence that the lack of effects of network control opportunities on buyer behavior in the data from the survey on IT-transactions is at least partly due to design, data, and measurement problems of the survey, including problems due to endogeneity of network embeddedness characteristics and sample selectivity. Clearly, these are no plausible arguments for the lack of network control effects on trustor behavior in the lab experiment. Thus, one might wonder whether the findings for

effects of control opportunities through network embeddedness indicate limits of strategic rationality. First, consider the situation of the trustee (or, respectively, the supplier). He has a good reason to react to the trustor's dyadic control opportunities *as well as* her network control opportunities when he anticipates that his present trustworthiness might affect future trustfulness of the same or other trustors. Similarly, the trustor has a good reason to react to her dyadic control opportunities when she anticipates that the trustee anticipates on how his present trustworthiness will affect her *own* future trustfulness. However, the trustor needs to reason 'more steps ahead' before having a good reason to react to her network control opportunities. Namely, she has to anticipate that the trustee anticipates on how his present trustworthiness will affect future trustfulness of *other* trustors and that *other* trustors will in fact condition their trustfulness on the trustee's present trustworthiness. It may be less likely that actors reason so many steps ahead, certainly in rather unfamiliar settings such as the lab experiment (see Binmore 1998, chapter 0.4.2 for general arguments in this direction). Future research could further explore this conjecture in various ways. For example, if the conjecture is correct, we would expect that effects of network control opportunities on trustor behavior are more easily found when trustors play repeated Trust Games with information exchange between trustors many times and specifically when they are also in the role of the trustee in some of those repeated game (see Palacios-Huerta/Volij 2006; 2008; Bednar/Page 2007; Bednar/Chen/Xiao Liu/Page 2008 for related arguments in different contexts and for empirical evidence on 'spillover effects' from natural situations to games and for spillover between games). Note that the findings from the vignette study on buyer-supplier relations are in line with this reasoning. After all, trustor behavior of experienced subjects, namely, purchase managers is observed in that study and these subjects do indeed react to network control opportunities.

3. Conclusion

Our contribution aimed at providing evidence, by way of example, for three related claims. The first of these claims has been that analytical theory and particularly rational choice theory in sociology and empirical research have moved closer to each other. We tried to show this by presenting quite some empirical research designed to test hypotheses derived from game-theoretic models on how embeddedness affects trust in economic exchange, rather than relying on illustrative examples and 'stylized facts' as evidence for theoretical models.

The second claim has been that the integration of theory and empirical research is served by employing complementary research designs for testing the same hypotheses. Our examples indicate this in various ways. Of course, the four studies allow for repeated tests of the same hypotheses and this is an advantage in itself. In addition, while each individual study certainly suffers from weaknesses and design problems, each individual study also has strengths that can compensate, at least to some degree, for other studies' weaknesses. Moreover and more specifically, consider our hypothesis on a negative interaction effect of

previous and expected future business on investments in ex ante management of a transaction, i.e., one of our hypotheses on control effects of dyadic embeddedness on trustor behavior. Supporting evidence for this relatively complex hypothesis from only one study, either the survey on IT-transactions or the vignette study on buyer-supplier relation, might raise the suspicion of a post hoc explanation. Such suspicion is considerably attenuated, we believe, by supporting evidence from two different studies using very different research designs. Finally, consider that our studies hardly reveal support for control effects of network embeddedness on trustor behavior. Since our studies employ different research designs, we could reduce, so to speak, the degrees of freedom with respect to the interpretation of this result. Of course, even though we have evidence from various studies, this does not allow coming up with the 'true' interpretation in an inductive way. However, having evidence from studies employing different designs allowed to conclude, e.g., that it is less plausible that our finding is the exclusive result of certain design weaknesses. Also, having evidence from studies employing different designs allowed for specifying plausible directions for further research on the phenomenon. Hopefully, such advantages of employing complementary research designs for testing the same hypotheses also lend plausibility to our suggestion that it makes sense to extend Goldthorpe's program for an alliance of rational action theory and quantitative analysis of data by conceiving his 'quantitative analysis of data' more broadly, including not only survey designs but also, e.g., experiments and quasi-experimental designs such as vignette studies.

Our final claim has been that the interplay of formal theoretical model building and empirical research is more complex than is sometimes believed. Indeed, in various ways, our empirical studies indicate the need for the development of more complex—rather than simpler—theoretical models, while an often encountered knee-jerk reaction of empirically minded sociologists seems to be that complex theoretical models are more of a nuisance for generating testable hypotheses and for empirical research. Clearly, the relatively simple models of infinitely repeated games with complete information as discussed in, e.g., Kliemt and Schauenberg (1982) have been the seminal starting point of much contemporary theoretical model-building in research on cooperation in problematic social situations. In our terminology, these models focus on control effects of dyadic embeddedness. Our empirical studies reveal, first, that effects of network embeddedness should not be neglected. This is a good reason for constructing and using more complex theoretical models that account not only for dyadic embeddedness but also for network embeddedness. Second, our empirical studies provide much evidence that embeddedness works not only through control effects but also and particularly through learning effects. This provides strong justification for increasing the complexity of game-theoretic models by considering games with incomplete information in order to be able to account simultaneously for control effects as well as learning effects of embeddedness. In addition, our empirical findings concerning the negative interaction effect of previous and expected future business on investments in ex ante management of transactions highlights that more complex theoretical models for repeated interactions are

useful in which behavior in a given round has effects for the payoff structure of the interactions in future rounds.¹⁴

We restrict suggestions for the research agenda to an item that is closely related to the findings from the empirical studies that we have reviewed in this contribution and to two issues of design improvements that aim at a still closer match of research designs and underlying theoretical assumptions. It is clear from our discussion above that more research on control effects of network embeddedness on trustor behavior would be useful that aims at identifying conditions under which such effects do or, respectively, do not emerge. In addition, notice that the designs of the survey on IT-transactions as well as both vignette studies are not optimal with respect to measurement and manipulation of the shadow of the future. First, from a theoretical perspective, the shadow of the future for the trustee, rather than for the trustor, is crucial (including, of course, common knowledge of trustor and trustee on the shadow of the future). However, all three studies tap or manipulate the trustor's rather than the trustee's expectations with respect to the shadow of the future. One thus needs the additional and possibly problematic assumption that the trustor's expectations coincide with those of the trustee. Designs would be preferable that allow for measuring or manipulating expectations of the trustee with respect to the shadow of the future more directly. Also, note that the design of the survey on IT-transactions implies that respondents answer retrospective questions on their expectations with respect to future business with the supplier at the time of the focal transaction. Thus, respondents had to recall an expectation from the past. The accuracy of answers to such retrospective questions is doubtful (e.g., Bernard/Killworth/Kronenfeld/Sailer 1985). In principle, prospective designs would allow for better measurements of the anticipated shadow of the future.

We started our contribution by recalling that analytical approaches in social theory and empirical research were far apart when *Analyse & Kritik* was launched 30 years ago. The focus of the journal on this issue was and is well-taken. We tried to show that there has been some progress with respect to the integration of analytical social theory and empirical research. Hopefully, in 2028, at the 50th anniversary of *Analyse & Kritik*, more progress will have been made and the aim as such of integrating analytical theory and empirical research will no longer be a debated issue.

¹⁴ Note that we focused on empirical evidence for and against implications from game-theoretic models in a very specific field, namely, embeddedness effects on behavior in trust problems as an example of problematic social situations. We do not wish to suggest that such models fare well empirically when applied elsewhere (see Buskens/Raub forthcoming for some discussion and references).

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